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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
FOWLKES, ANDRE R	
ART UNIT	**PAPER NUMBER**
2192	

DATE MAILED: 10/27/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/965,757	WU, YOUFENG	
	Examiner	Art Unit	
	Andre R. Fowlkes	2192	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 June 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-17* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 6/23/05 has been entered.

Claim Rejections - 35 USC § 101

2. The rejection of claims 9-16 under 35 U.S.C. 101 is withdrawn, in view of applicant's amendment.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lowry et al. (Lowry), "Object Code Optimization", Communications of the ACM, in view of Chang et al. (Chang), "Using Profile Information to Assist Classic Code

Optimizations", Software—Practice & Experience, further in view of Mills et al., (Mills), U.S. Patent No. 6,205,544.

As per claim 1, Lowry discloses a **system comprising a compiler to generate object code from a computer program, a code optimizer to optimize the object code generated by the compiler** (p. 13 col. L:46 - col. R:3, "(the) compiler performs the most thorough analysis of source code and produces the most efficient (optimized) object code"), **the code optimizer including:**

- a first device to formulate regions (p. 14 col. L:17-18, "the program is broken into computational 'blocks' (i.e. regions)"),

- a second device to select initial regions from the formulated regions (p. 14 col. L:17-18, "the program is broken into computational 'blocks' (and the regions are selected)"),

- a third device to apply code motion (p. 21 col. L:29-30, "Elimination of unnecessary unconditional braches by reordering the code"),

- a fifth device to compute UEU(E,R) and DED(X,R), wherein UEU(E,R) represents a number of upward exposed registers at a main entry E of a region R that are used in the region R and DED(X,R) represents a number of downward exposed registers at a main exit X of the region R that are defined in the region R (p. 20 col. R:20-30, The number of upward exposed registers, UEU(E,R), and the number of downward exposed registers, DED(X,R), are computed for each command, and notated as follows: "11—The operand is available in a register and it must be

retained in that register after the operation (i.e. UEU(E, R)), and 00—The operand must be fetched from storage and retained in a register after the operation (i.e. DED(X,R))"),

- a memory to store the compiler and the code optimizer, and a central processing unit (CPU) cooperatively connected to the memory to execute the compiler and the code optimizer (p. 22 col. R:26-27, "storage (i.e. memory) speed and ... CPU's").

Lowry doesn't explicitly disclose **a fourth device to apply tail duplication.** However, Chang, in an analogous environment, discloses **a fourth device to apply tail duplication** (p. 13:4-5, "More code transformations are applied after tail duplication").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Chang into the system of Lowry to apply tail duplication. The modification would have been obvious because one of ordinary skill in the art would have wanted to use the well-known technique of tail duplication to further optimize the program code.

The Lowry/Chang combination doesn't explicitly disclose a fourth device to **apply tail duplication to separate instruction.** However, Mills, in an analogous environment, discloses a fourth device to **apply tail duplication to separate instructions** (col. 7:5-18, "Furthermore, those of ordinary skill within the art can appreciate that the decomposition accomplished by at least some embodiments of the

invention may require compiler considerations (i.e. tail duplication). Given that the downside costs, in terms of increased code size, of such control flow optimizations as tail duplication are dramatically reduced by the decomposition performed in accordance with at least some embodiments of the invention, the compiler can thus make more aggressive use of these types of optimizations").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Mills into the Lowry/Chang system to apply tail duplication to separate instructions. The modification would have been obvious because one of ordinary skill in the art would have wanted to use the well-known technique of tail duplication to isolate certain instructions to further optimize the program code.

As per claim 2, the rejection of claim 1 is incorporated and further, Lowry discloses that **the second device selects initial regions by selecting sub-control flow graphs as regions such that the region starts execution mostly at the main entry and completes mostly at the main exit** (p. 14 col. L:15-40, "the program is broken into computational 'blocks' ... Each block consists of a sequence of statements, only the first of which may be branched to (i.e. execution starts at the main entry), and only the last of which contains a branch (i.e. execution completes at the main exit)").

As per claim 3, the rejection of claim 1 is incorporated and further, Lowry discloses that **the fifth device computes UEU(E,R) and DED(X,R) using local information from the region R** (p. 20 col. R:20-30, The number of upward exposed registers, UEU(E,R), and the number of downward exposed registers, DED(X,R), are computed for each command and notated as follows: "11—The operand is available in a register and it must be retained in that register after the operation (i.e. UEU(E, R)), and 00—The operand must be fetched from storage and retained in a register after the operation (i.e. DED(X,R))").

As per claim 4, the rejection of claim 1 is incorporated and further, Lowry discloses that **the third device applies code motion by moving instructions outside the region R into the region R** (p. 21 col. L:29-30, "Elimination of unnecessary unconditional branches by reordering the code (i.e. code motion)", and code motion is used to move instructions to/from the entry, interior, and/or exit of a region, R).

As per claim 5, the rejection of claim 4 is incorporated and further, Lowry discloses that **the third device moves instructions outside of the region R into the main entry E and the main exit X of the region R** (p. 21 col. L:29-30, "Elimination of unnecessary unconditional branches by reordering the code (i.e. code motion)", and code motion is used to move instructions to/from the entry, interior, and/or exit of a region, R).

As per claim 6, the rejection of claim 5 is incorporated and further, Lowry discloses that **the third device moves instructions outside of the region R into the main entry E and the main exit X of the region R, and later moves the instructions from the main entry E and the main exit X of the region R to other places inside the region R** (p. 21 col. L:29-30, "Elimination of unnecessary unconditional branches by reordering the code (i.e. code motion)", and code motion is used to move instructions to/from the entry, interior, and/or exit of a region, R).

As per claim 7, the rejection of claim 1 is incorporated and further, Lowry doesn't explicitly disclose that **the fourth device applies tail duplication to separate reusable instructions executed along a side entry after selection of initial regions**.

However, Chang, in an analogous environment, discloses that **the fourth device applies tail duplication to separate instructions executed along a side entry after selection of initial regions** (p. 13:2-3, "we duplicate the tail part of the ... trace (to separate the instructions)").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Chang into the system of Lowry to apply tail duplication to separate the instructions. The modification would have been obvious because one of ordinary skill in the art would have wanted to use the well-known technique of tail duplication to separate the instructions and then further optimize the program code.

As per claim 8, the rejection of claim 1 is incorporated and further, Lowry doesn't explicitly disclose that **the fourth device applies tail duplication during application of code motion**.

However, Chang, in an analogous environment, discloses that **the fourth device applies tail duplication during application of code motion** (p. 13:4-5, "More code transformations (i.e. code motion) are applied after tail duplication").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Chang into the system of Lowry to apply tail duplication during code motion. The modification would have been obvious because one of ordinary skill in the art would have wanted to use the well-known techniques of tail duplication and code motion to further optimize program code.

5. Claims 1-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lowry et al. (Lowry), "Object Code Optimization", Communications of the ACM, in view of Chang et al. (Chang), "Using Profile Information to Assist Classic Code Optimizations", Software—Practice & Experience, in view of Mills et al., (Mills), U.S. Patent No. 6,205,544, further in view of Bharadwaj, U.S. Patent No. 5,787,287.

As per claim 9, Lowry discloses:

- computing UEU(E,R) and DED(X,R), wherein UEU(E,R) represents a number of upward exposed registers at a main entry E of a region R that are used in the region R and DED(X,R) represents a number of downward exposed

registers at a main exit X of the region R that are defined in the region R (p. 20 col. R:20-30, The number of upward exposed registers, UEU(E,R), and the number of downward exposed registers, DED(X,R), are computed for each command, and notated as follows: "11—The operand is available in a register and it must be retained in that register after the operation (i.e. UEU(E, R)), and 00—The operand must be fetched from storage and retained in a register after the operation (i.e. DED(X,R))"),

- **applying code motion** (p. 21 col. L:29-30, "Elimination of unnecessary unconditional braches by reordering the code"),

Lowry doesn't explicitly disclose **applying tail duplication.** However, Chang, in an analogous environment, discloses **applying tail duplication** (p. 13:4-5, "More code transformations are applied after tail duplication").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Chang into the system of Lowry and **applying tail duplication**. The modification would have been obvious because one of ordinary skill in the art would have wanted to use the well-known technique of tail duplication to further optimize the program code.

The Lowry/Chang combination doesn't explicitly disclose a fourth device to **apply tail duplication to separate instruction.** However, Mills, in an analogous environment, discloses a fourth device to **apply tail duplication to separate instructions** (col. 7:5-18, "Furthermore, those of ordinary skill within the art can

appreciate that the decomposition accomplished by at least some embodiments of the invention may require compiler considerations (i.e. tail duplication). Given that the downside costs, in terms of increased code size, of such control flow optimizations as tail duplication are dramatically reduced by the decomposition performed in accordance with at least some embodiments of the invention, the compiler can thus make more aggressive use of these types of optimizations").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Mills into the Lowry/Chang system to apply tail duplication to separate instructions. The modification would have been obvious because one of ordinary skill in the art would have wanted to use the well-known technique of tail duplication to isolate certain instructions to further optimize the program code.

The Lowery/Chang/Mills combination doesn't explicitly disclose selecting initial regions **based on completion probabilities.** However, Bharadwaj, in an analogous environment, discloses selecting initial regions **based on completion probabilities** (col. 11:8-16, "Associated with each control flow path is a probability that the particular path will be taken during execution of the program (i.e. a completion probability). It is useful to know how speculative (wasteful) a code motion is (i.e., likelihood of the instruction being executed unnecessarily). This speculativeness is simply the sum of the probabilities of the paths which have their corresponding bits set in the speculation path

vector. Using this measure during instruction scheduling, less speculative code motions can be given preference over more speculative code motions.").

Therefore, it would have been obvious to a person of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Bharadwaj into the Lowry/Chang/Mills combination and selecting initial regions **based on completion probabilities**. The modification would have been obvious because one of ordinary skill in the art would have wanted to efficiently optimize the program code by applying optimizations to the code most likely to be executed.

As per claims 10-16, this is a method version of the claimed system discussed above, in claims 2-8, wherein all claimed limitations have also been addressed and/or cited as set forth above. For example, see Lowery p. 14 col. L:17- p. 21 col. L:30, Chang, p. 13:4-5 and Mills, col. 7:5-20.

As per claim 17, this is a machine readable medium version of the claimed method discussed above, in claim 9, wherein all claimed limitations have also been addressed and/or cited as set forth above. For example, see Lowery p. 14 col. L:17- p. 21 col. L:30, Chang p. 13:4-5, Mills col. 7:5-20 and Bharadwaj col. 11:8-16.

Response to Arguments

6. Applicant's arguments, at p. 5:15-6:8, with respect to claims 1 and 9 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Andre R. Fowlkes whose telephone number is (571) 272-3697. The examiner can normally be reached on Monday - Friday, 8:00am-4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tuan Q. Dam can be reached on (571)272-3695. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

ARF

TUAN DAM
SUPERVISORY PATENT EXAMINER